APPARATUS AND METHOD FOR GENERATING DENTAL PANORAMIC IMAGES

TECHNICAL FIELD

The invention generally relates to dental panoramic imaging and, more particularly, to generating digital dental panoramic images from multiple frame images acquired during a dental panoramic imaging scan about a patient's head.

BACKGROUND OF INVENTION

A traditional operation principle of panoramic X-ray apparatuses includes driving an X-ray source and a film cassette around a patient's head while a film is moved with respect to the X-ray beam in such a way that the dental arch will be imaged as a planar picture on the film.

This basic operation of the traditional dental panoramic imaging includes creating a respective mutual movement between the X-ray source, the image information receiver and the patient.

While there are number of possibilities to create such movement, the most common arrangement has been to attach the X-ray source and the image information receiver to a support arm at a distance from each other, which arm is then moved in a specific way with respect to a stationary patient. In such context, in order to obtain a sharp image of a desired layer within the object, i.e. the layer of a dental arch within a patient's head, the velocity of movement of the film has to be specifically correlated with the sweep velocity of the X-ray beam along the desired layer to be imaged. By this arrangement, the undesirable structures in front of and behind the desired layer within the patient's head are blurred invisible.

In the traditional panoramic imaging, the thickness of the layer that will be photographed sharp is directly proportional to the distance of the instantaneous center of rotation of the support arm from the film level, and inversely proportional to the magnification and to the width of the beam.

This basic equation of panoramic imaging can be expressed as follows:

$$v1/v0=L1/L0$$

$$v0=\omega r$$

where:

L0=distance from the X-ray tube focus F to a point of the object being imaged at a given moment;

L1=distance from the X-ray tube focus F to the X-ray film (or detector) plane;

ω=angular velocity of rotational movement about the instantaneous center of rotation;

r=distance of the point of the object being imaged from the instantaneous center of rotation; and

v**1**=velocity of the image point on the film (detector) plane.

The velocity v**1** thus relates to the speed by which the film is moved during the panoramic imaging scan relative to the x-ray beam hitting the film. As to digital imaging, when a so-called TDI imaging technique (Time Delayed Integration) is used, the transfer velocity of pixel charges across the detector is made to correspond to the velocity of film movement. Thus, the image data read out from the sensor will correspond to the panoramic film image in the sense that blurring of the layers outside the desired layer is already done when the scanning process and charge transfer are carried out so as to follow this imaging equation. In this context, as far as selecting the tomographic layer to be shown is concerned, post exposure image processing is not needed nor would it even be possible, as the data read out from the sensor already represents the very layer the velocity v**1** corresponds to.

Prior art digital panoramic imaging also includes a so-called FT (Frame Transfer) technique. When using FT or any other technique in which a number of individual overlapping frames are shot during the imaging scan, when one wishes to view the same layer as one would get when following the traditional panoramic imaging equation presented above, the degree of overlap of the frames when constructing the layer to be viewed as sharp shall be made to correspond to the velocity v**1**.

One advantage the frame technique brings along is that since the degree of overlap of the frames used in the image processing determines the layer that will be relatively intensified while the others will be blurred, by altering the degree of overlap on can change the tomographic layer to a certain degree after the exposure. The extent one is able to alter the layer depends on how and by which kind of means the frame data has been acquired. Typically, however, only marginal changes in the location of the layer are possible.

Still, while the prior art frame panoramic systems include the possibility to marginally alter the sharp layer, the degree of overlap used in the image construction is based on some predetermined scheme. These schemes typically include using a standard overlap of the frames and the actual calculation of the panoramic image does not include any parameter which would relate to the actual imaging geometry of the imaging system at the exposure positions of the frames.

Further, as the viewing direction of the anatomy is primarily dictated by the imaging geometry used to obtain the frame data, i.e. by the geometry according to which the imaging means (the x-ray source and the image information receiver) move when the frame data is acquired, the prior art systems are stuck with that viewing direction as they lack means to alter a viewing direction from which the panoramic images or sections of them are shown.

Further, even though the frame imaging technique makes it possible to use wider detector areas than possible in practice when using the more traditional continuous scanning techniques, there are criteria such as those relating to the necessity to be able to read out a frame fast enough during the imaging scan, as well as not to have major alterations in the magnification ratio within a single frame, which have set practical limits also to the width of the detectors one can use in the prior art dental panoramic frame imaging.

SUMMARY OF THE INVENTION

The main objective of the invention and its preferable embodiments is to provide a system by which the frame image data acquired in a single panoramic imaging scan can be used in relation to knowledge of the true imaging geometry used in the imaging procedure, regarding each exposure position, so as to provide new possibilities for generating dental panoramic images from the frame data after the exposure. Secondary objectives of the invention include making it possible to not only generate more than one tomogaphic layer from the frame image data acquired in a single panoramic imaging scan but also to construct and display images or partial images of dental arch as viewed from different directions.

These and other objectives of the invention that will be discussed below can be reached by embodiments of the invention as defined in the attached claims. The core of the invention is to implement the panoramic scan so that information of the imaging geometry, that is location and orientation of the